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ADAPTATION IN ANIMAL REACTIONS[1]

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In recent times no feature of animal or plant life has been accorded greater emphasis than adaptation, and this property has been repeatedly declared to be one of the fundamental characteristics, if not the most fundamental, of living bodies. Nevertheless, the field of organic adaptation has been scarcely more than superficially surveyed. With the naïve instinct of the collector, the biologist has been content to roam over this vast territory and gather here and there what seemed to him to be striking examples of adaptation till our texts are rich storehouses of instances of nature's apparent ingenuity. How well founded even the more striking of these examples are, no one really knows, though the effect of the whole collection on the naturalist is to engender in him a feeling akin to awe for the adaptive capacity of living beings. May it not be, however, that we overestimate this aspect of organic nature and emphasize beyond reason its real value as a factor in the organic world? It is my opinion, at least, that many animal reactions which we have been accustomed to call adaptations should not be thus designated, and that the difficulties that we often meet in attempting to account for such reactions are due to our consideration of them from the standpoint of adaptations when in reality they are far from being such.

Adaptations are indissolubly connected with the activities of animals and plants. We are only just beginning to learn that an organism in its essentials is an active, working system, that the moment we think of it as a machine standing still, we divest it of precisely that element which is most distinctive of it. The anatomical conception of an organism as a mechanism at rest, useful and important as it has been and is still, is thus fundamentally defective. The essential feature of every living thing is incessant activity, and adaptations are part and parcel of this activity. Even such apparently passive examples as the adaptation of a moth to the bark of the tree on which it rests depends for success as much on the position of the moth's body, the pose of its wings, etc., all features of muscular action, as upon the color pattern of the exposed parts. Thus adaptation, like other truly organic phenomena, exhibits a fundamental dependence on organic activity, a condition that favors the conception of the organism as put forward long ago by Lamarck.

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[1] Read at the Symposium on Adaptation at the meeting of the American Society of Naturalists, Cleveland, January 2, 1913.

But adaptation is not only essentially associated with the activities of organisms; it is also conditioned by the continuity of this activity. Every organic line of descent has had its past history and can look forward to a possible future. The continuity thus indicated is an essential part of organic nature. The inorganic may at any moment be completely resolved into its elements and recombined at the next moment into a new order without violating the law of its existence. But an organism can not undergo such a revolution without annihilation; an animal or plant subjected to such a process would cease to exist. Hence life is not only activity; it is activity so directed as to be continuous, to be self-perpetuating. Continuity of action is, therefore, an inherent part of the make-up of living things, and adaptation is conditioned by this continuity in that those reactions are adaptive which make for a continuance of life.

Strictly speaking, adaptations exist no more in nature than does a species; it is a word in the dictionary, a figment of the human brain. Just as the systematist finds the individual animal or plant the real object of his investigation, so the student of adaptation finds individual animal movements the material for his study. Broadly speaking, these movements range from the hidden internal processes in the animal economy to the more obvious external forms of behavior.

The very fact that adaptations have been classed under one head to the exclusion of other forms of animal reactions has given them a certain undue prominence, but this is not the only reason for their usurping more than a fair share of attention. Many animal reactions that are in no proper sense adaptations have been brought under this head, and in certain quarters this process of appropriation has gone to such an extent that every animal reaction has been supposed to have some adaptive significance. How far this is from the truth can be made clear by a homely example. When a person faints, his best position for recovery is a horizontal one, and into approximately this position he is very likely to fall. Furthermore, he falls with limp muscles, a method which under the circumstances is much safer than that of falling with a tense body such as usually occurs in consciousness. Thus the position into which a fainting person falls and the method of arriving at it, have all the appearances of adaptations. Yet, in my opinion, any one who would interpret these movements as adaptations would lay himself open to a charge of unreality. The new position, favorable as it is for recovery, is in fact the mere consequence of the faint, and as such it completely loses any claim as an adaptation. That it is advantageous is purely incidental; it might equally well have been disadvantageous. Thus responses, even when of a favorable nature, are not necessarily adaptations, though they may resemble them to a striking degree. An adaptation is not only a favorable response, it is a favorable response especially developed to meet a particular emergency.

If it is so easy to point out pseudo-adaptations among our own activities, it is highly probable that they also occur among the responses of the lower animals. And such seems to be the case. That an isolated blastomere representing a half or a quarter of the egg of *Amphioxus* should be able under favorable conditions to develop into a complete larva is at first sight a surprising fact and seems to give evidence of a remarkable power of adaptation. But such an interpretation is far from justifiable. The growth of the isolated blastomere seems to me much more like the falling of a fainting person than like a process devised to meet a special emergency, and, important and illuminating as this growth is from the standpoint of our understanding of the mechanism of the egg, it is, I believe, a good case of pseudo-adaptation rather than of true adaptiveness. All eggs certainly do not show this trait and to single out the egg of *Amphioxus* and extol this reaction as an adaptation is to give to it weight beyond its deserts. To call this an adaptation is to read adaptation into it as only an overzealous advocate could do. Dame Nature under the circumstances might well be likened to a certain English poet, who, on visiting incognito an exposition of his own verses, was amazed at the wonders they were said to contain.

The majority of animal reactions are, in all probability, neither conspicuously advantageous nor disadvantageous to the life of the individual. They are dependent chiefly on the material composition of the given organism, and, so long as they are relatively indifferent to the continuance of life, they pass without special consequence. Relatively speaking only now and then do we have conditions where a vitally important form of response, an adaptive response, appears. On the whole the flow of action in the daily life of many organisms requires little of such special activity and proceeds at the level of mild indifference. In other words, adaptive reactions as the controlling factors in animal life are, I believe, by no means so universal as some of their advocates would have us think.

The world at large affords an environment in which each animal has a wide range for possible reactions and of a number of responses that might be made to a given set of conditions, one may be quite as appropriate for the continuance of life as another. In other words versatility seems to be a more truthful description of the actual conditions in animal life than the rather rigid state implied in the application of the idea of adaptive responses. Animal reactions in most cases seem to be more of the nature of fluctuations than of mutations, to borrow a related phraseology; they are individual idiosyncracies that are insignificant so far as the race is concerned and are usually not interfered with because of the generous latitude permitted by the environment. From this standpoint animal reactions have a variety whose explanation is to be sought for, as adaptations, but as an expression of the momentary physical and chemical make-up of the individual, a condition which does not easily repeat itself and which therefore agrees with the diversity of reactions exhibited by the organism.

Yet it is not for a moment to be assumed that adaptations are not evident among animal reactions. When it is remembered what enormous numbers of young are lost in the process of producing one adult and that much of this loss is due to misdirected animal reactions, it is impossible to believe that adaptations, as roughed out by a crude selective process, should not have become ingrained in most animals. In fact any adequate survey of the general field of animal reactions shows at once that the main topographic features are adaptational and when one reflects that this has probably been brought about in large part by the elimination of myriads of individuals mainly on the basis of some false step in their reactions, one is compelled to admit that in our zeal for the study of animal behavior, we may have missed the importance of the lesson to be drawn from animal misbehavior. But however this may be, I am convinced that, though the main reaction systems of animals are essentially adaptive, the details of their ordinary flow of responses is mostly free from adaptive influence and proceeds on lines determined chiefly by the momentary state of the individual concerned.

That animal reactions of an adaptive kind may possess qualities that apparently exceed the possibility of origin through selective operations has often been pointed out. In fact it is from this standpoint that adaptation as a sort of transcendental property of the organism has gained its most ardent votaries. And it must be admitted that the illustrations given in support of this view are most baffling and perplexing to the opponents. That a dog which has had its diet changed from bread to meat, should quickly exhibit a change in its pancreatic juice from a type well adapted to bread and poorly adapted to meat to another in which the reverse is true, is a fact of adaptation the explanation of which seems beyond reach. Here we are face to face with what appears to be a quick adaptation of a thoroughly successful kind and without the intervention of nervous activity. No wonder that in face of facts, such as these, the more speculative members of the biological camp seize their entelechies as the only weapons with which they may hope to do battle. But after all is the entelechy a reliable weapon. In all reactions of the kind just mentioned, we are prone to say that though there is not the least reason to suppose that intelligence has really intervened, the whole affair passes off as though directed by some such agent; hence we assume some intelligence-like factor, some entelechy, to be active for the time. But when we look at the matter deliberately, we must admit that intelligence is only our own expression for that aggregate of nervous states and actions which is our chief means of adaptation. To say then that one category of adaptive acts, the adjustment of secretions to particular kinds of food, has a fundamental resemblance to another category of adaptive acts, our intelligent performances, is not to offer an explanation but to leave the matter where it was. When we know more of the real nature of intelligence, we shall be in a better position to attack the problem of adaptive reactions, and, conversely, when we know more about adaptive reactions, we shall be in a better position to attack the problem of intelligence. Meanwhile, do not let us deceive ourselves by confusing an argument in a circle with real progress. In attempting a solution of the problem of adaptive reactions, it is well to remember that entelechies and other like notions do not really bring us forward, for they are at most soporifics to the mind that would naturally be excited to research by precisely those questions that they tend to obscure.

In conclusion then I would maintain that the details of animal reactions are in the main free from adaptive restraint and that their diversity is dependent chiefly upon the fluctuating momentary condition of the animal body; further, that the main outlines of animal reactions are adaptive, but that when we attempt to explain this condition by assuming that it is dependent upon something like intelligence, we are arguing in a circle, for intelligence is merely our name for our own chief means of adaptation.